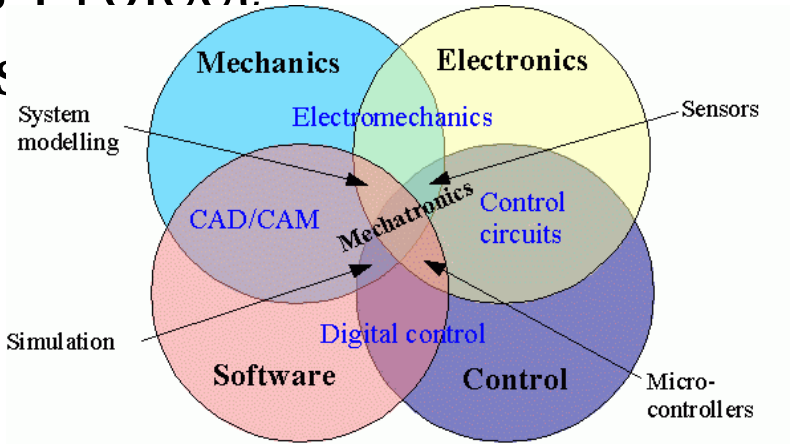
Model-based Engineering : Electromechanical Integration

Peter Denno
National Institute of Standards and Technology

NIST
National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

Overview

- Two projects in mechatronics provide pathways to demonstrate real-world SoS capability with AP210, AP233 and DoDAF:
  - PDES Inc Mechatronics Project
  - NGMTI Mechatronics "s



NGMTI Project

- Next Generation Manufacturing Technology Initiative
- DoD and OA -sponsored
- 3 Subprojects
  - Includes a mechatronics subproject in which we might focus
    on ECAD/MCAD integration
  - Participants includes many PDES Inc participants
- Participants attending PDES Inc Off-site

PDES Inc Mechatronics Project

- Nascent project
  - Organizing meeting next week at PDES Inc off-site
- Conceived as a joint AP233 / AP210 project

Motivation

(from Mike Loeffler's slides, GM)

- Real world ECS engineers are asking for "requirements management tools"….
- …but when we analyze the needs we find they are really asking for a way to get their requirements to link naturally and easily to the rest of the design process, especially the configuration management of effectivity, options and variants
- No Systems Engineering tool by itself can do this, it must be part of enterprise product lifecycle management architecture

Motivation

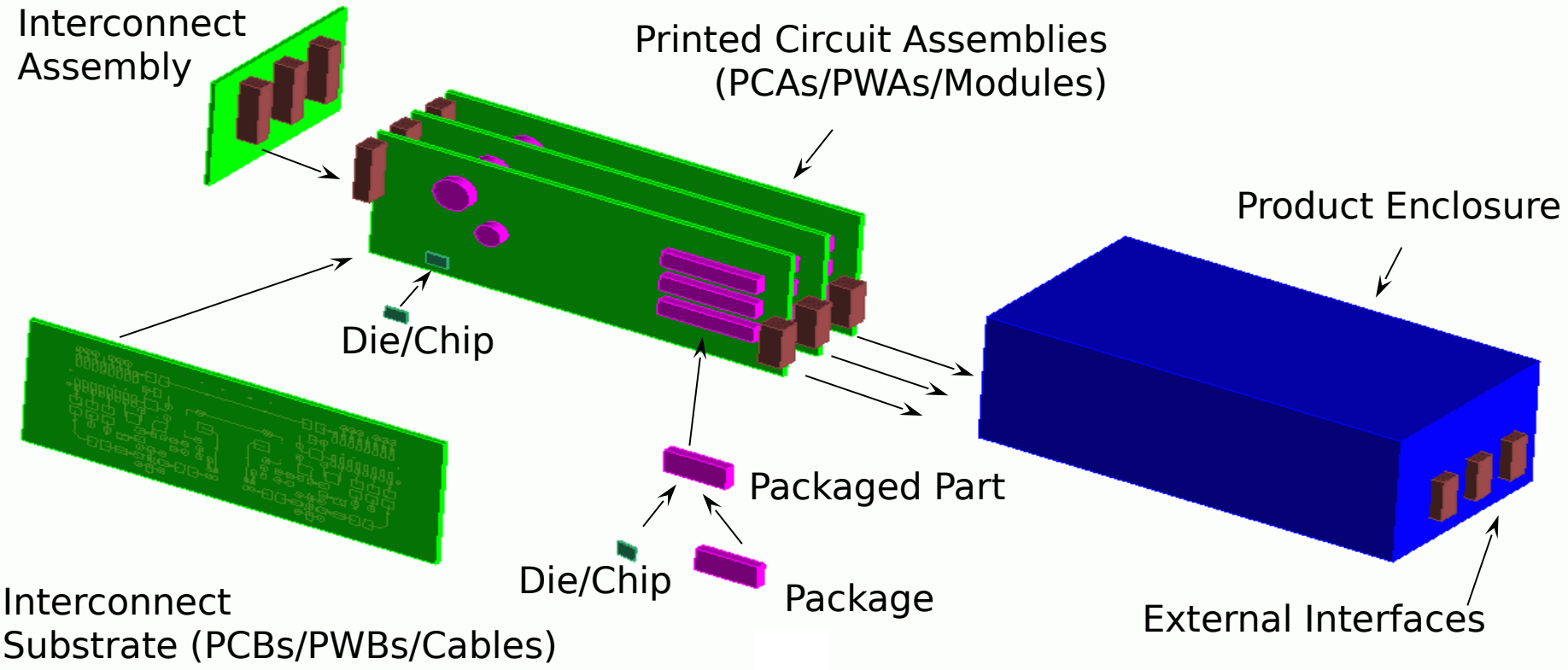
(from Mike Loeffler's slides, GM)

- After requirements are captured and controlled they must also be linked and related to the models that represent the product to be constructed
- The other two "legs of the stool" are Behavioral and Physical definition
- Links (decomposition and allocation) among all three of these are the stuff of design decision making

AP210

- ISO 10303-210 : Electronic Assembly Interconnect and Packaging Design
- Like DoDAF, AP210 is an integration schema designed to reveal cross-discipline interrelations and enable
  cross-discipline cooperation
- Scope of AP210:
  - Requirements
  - Functions
  - Assemblies
  - Parts
  - Interconnect
  - Rules / Engineering Analysis

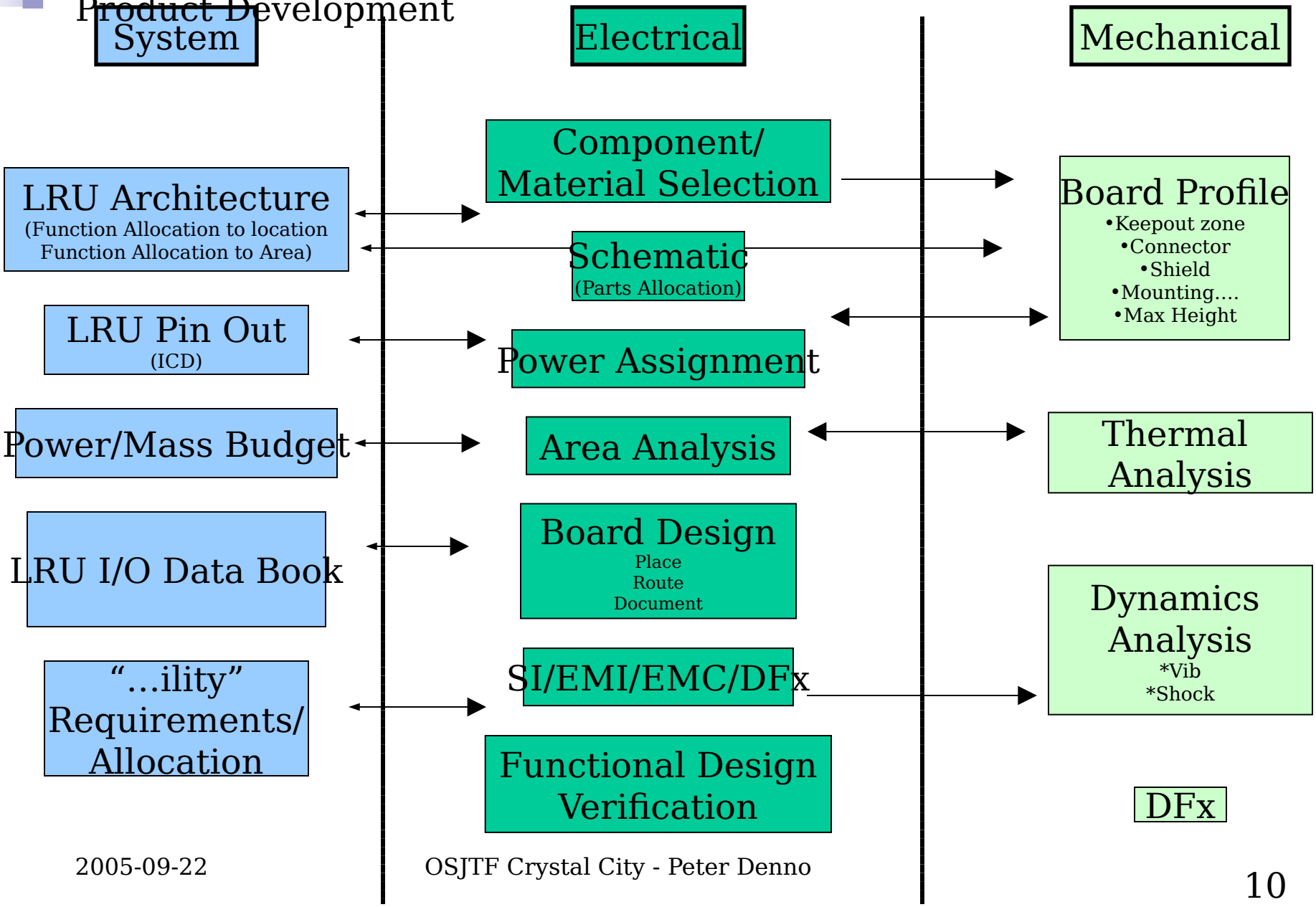
AP210 multiple levels of detail - supporting ECAD/MCAD integration



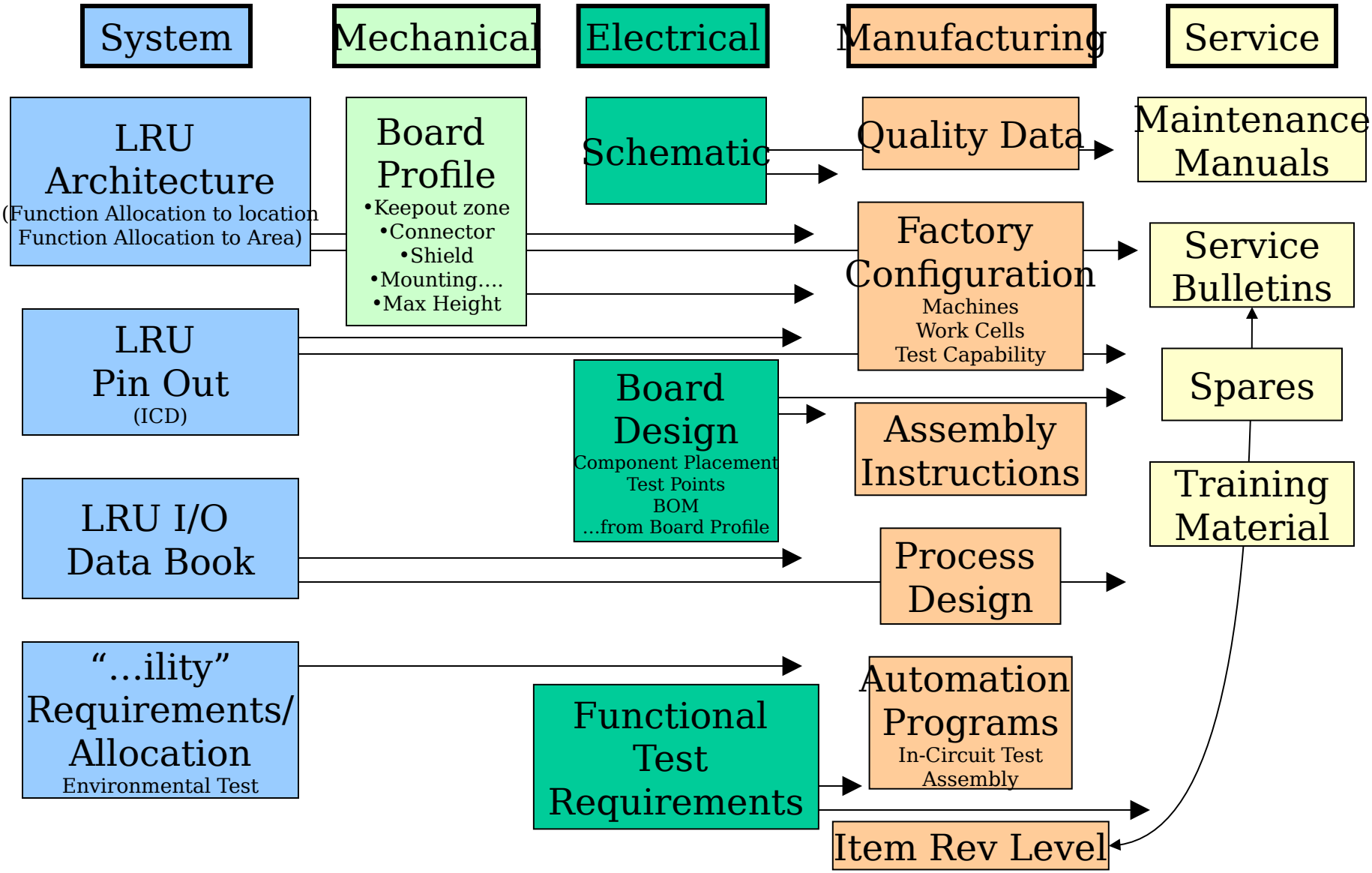
The Plan:

- Task: Produce a tool that allows the user to refine requirements from AP233 SE requirements definitions
  - User extracts electromechanical details from product data sheets, SPICE simulations, etc., elaborating on requirement as expressed in AP233.
  - User creates reusable library components
- Case Study: provided by a DoD Contractor (e.g. Rockwell Collins)
- Goal: Move to a transaction-based design process & tool chain
- Map to CADM
- Demonstrate:
  - A standards-based tool chain spanning several engineering disciplines
  - Identify gaps in CADM SoS integration ability
- Leverage : A family of engineering tool chains based-on the 210 model

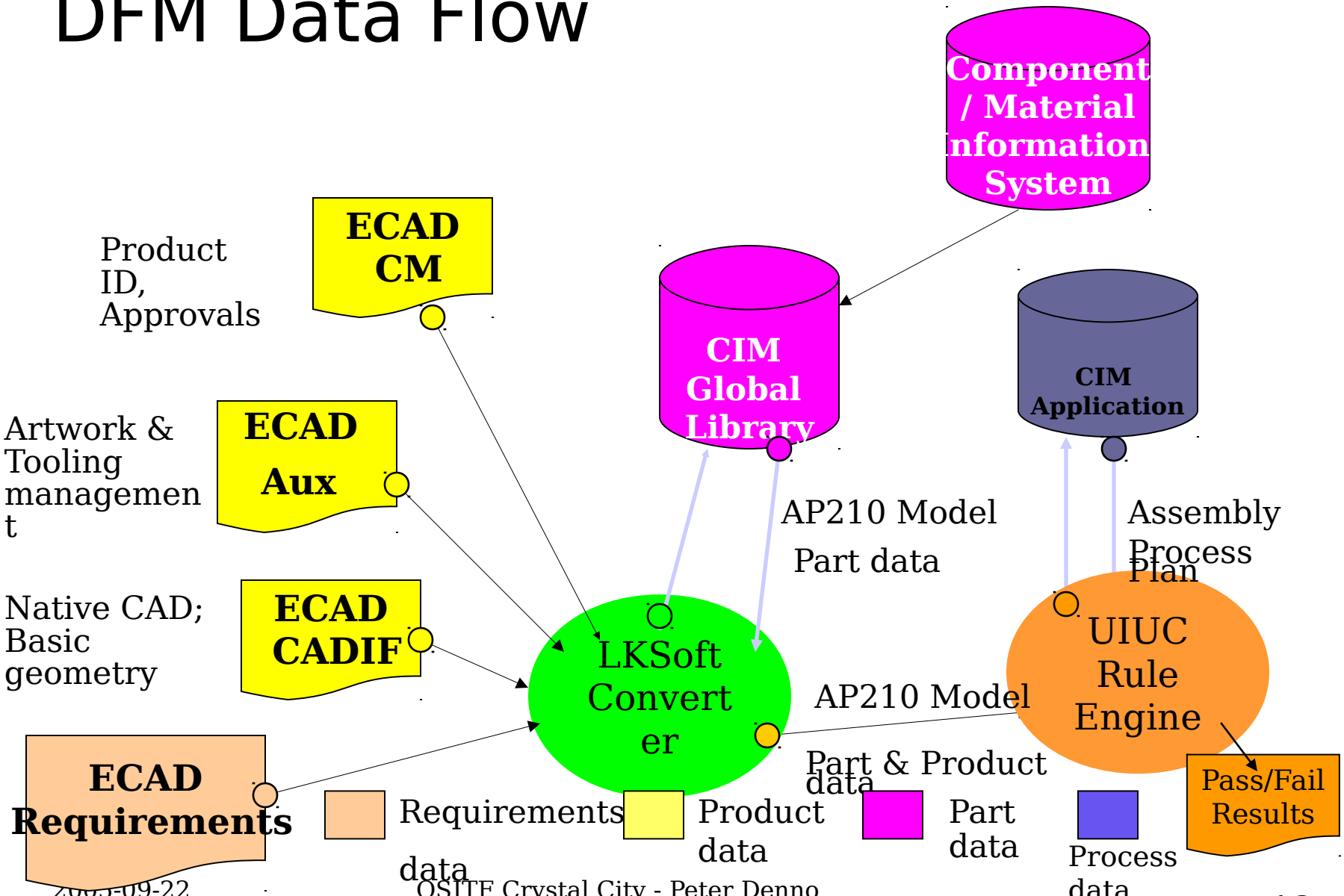
Engineering Data Flow Between Activities During Product Development



Data Flow Following Product Development



DFM Data Flow



Assembly Inputs

- Board Shape (xyz)
- Fiducials (board)
- Mounting holes (board)
- Component Orientation/location/pinout(1..n)(off grid location of connectors)
- Tooling holes (board)
- 3D shape/2D shape (custom views)
- Panelization (board)
- Wire/Cables—3d as assembled into LRU

Manufacturability Inputs

- Acceptable board warpage (3D model)
- Positional GD&T (mounting/size/connector location (off grid)) (board)
- Connector (pin 1..n)
- Material Composition, identification—Lead Free
- Keep-out zone (basis - e.g., design . . manufacturing requirement), target (e.g., component, trace, holes, shield, cover), skyline (board/LRU)
- Max top height / Max bottom height (board)

Engineering Analysis Inputs

- Mass Properties
- Percent Copper coverage on a layer basis
- Selected copper layer shapes(1..n) (board)
- Component thermal models
- PWB Stackup Definition
- Operational power assignments on a component basis
- Material properties (CTE, density)
- Shielding

Engineering Analysis Inputs

- Underfill / backfill data for thermal requirements
- Underfill / backfill data for dynamics requirements
- Via characteristics & requirements (electrical / thermal / filled)
- Bonding requirements (electrical, thermal) (e.g., chassis ground area bare surface finish)
- Mating Conditions
- Electrical Connectivity Definition

References

- Slides from:
  Tom Thurman - Rockwell Collins
  Lothar Klein - LKSoft
  Mike Loeffler - General Motors
  Wikipedia - Mechatronics Graphic

Back-up slides